

EXHIBIT I

MAAP-011247



Power Amplifier, 2 W DC - 22 GHz

Preliminary - Rev. V1P

Features

- High Gain: 12 dB
- P1dB: 30 dBm
- P_{SAT}: 33 dBm
- Output IP3: +42 dBm
- Bias Voltage: V_{DD} = 15 V
- Bias Current: I_{DSQ} = 500 mA
- 50 Ω Matched Input / Output
- Temperature Compensated Output Power Detector
- Lead-Free 5 mm 32-lead AQFN Package
- RoHS* Compliant

Description

The MAAP-011247 is a 2 W distributed power amplifier offered in a lead-free 5 mm 32-lead AQFN package. The power amplifier operates from DC to 22 GHz and provides 12 dB of linear gain and 33 dBm of saturated output power. The device is fully matched across the band and includes a temperature compensated output power detector.

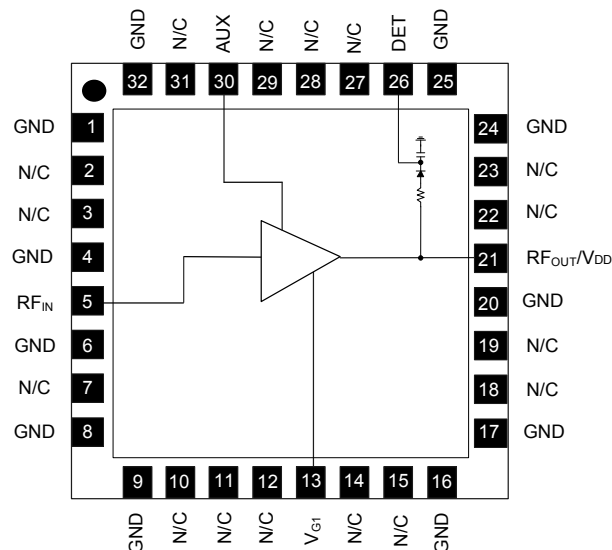
The MAAP-011247 can be used as a power amplifier stage or as a driver stage in higher power applications. This device is ideally suited for test and measurement, EW, ECM, and radar applications.

This product is fabricated using a GaAs pHEMT process which features full passivation for enhanced reliability.

Ordering Information

Part Number	Package
MAAP-011247-000PPR	Bulk
MAAP-011247-EV1PPR	Sample Board

Functional Schematic



Pin Configuration^{1,2}

Pin No.	Pin Name	Description
5	RF _{IN}	RF Input
13	V _{G1}	Gate Voltage
21	RF _{OUT} /V _{DD}	RF Output / Drain Voltage
26	DET	Power Detector
30	AUX	Auxiliary
1, 4, 6, 8, 9, 16, 17, 20, 24, 25, 32	GND	Ground
2, 3, 7, 10 - 12, 14, 15, 18, 19, 22, 23, 27 - 29, 31	N/C	No Connection

1. MACOM recommends connecting all no connection pins to ground.
2. The exposed pad centered on the package bottom must be connected to RF, DC and thermal ground.

*Restrictions on Hazardous Substances, European Union Directive 2011/65/EU.

MAAP-011247
**Power Amplifier, 2 W
DC - 22 GHz**
Preliminary - Rev. V1P
Electrical Specifications: $T_A = +25^\circ\text{C}$, $V_{DD} = 15\text{ V}$, $I_{DSQ}^3 = 500\text{ mA}$, $Z_0 = 50\ \Omega$

Parameter	Test Conditions	Units	Min.	Typ.	Max.
Gain	2 GHz 12 GHz 18 GHz 22 GHz	dB	—	12.0 11.5 12.0 11.5	—
P_{SAT}	2 GHz 12 GHz 18 GHz 22 GHz $P_{IN} = +23\text{ dBm}$	dBm	—	32.0 33.5 33.0 31.0	—
P1dB	2 GHz 12 GHz 18 GHz 22 GHz	dBm	—	30.0 31.0 30.0 28.0	—
OIP3	2 GHz 12 GHz 18 GHz 22 GHz $P_{IN} = +20\text{ dBm/ tone (10 MHz Tone Spacing)}$	dBm	—	42.0 46.0 42.0 44.0	—
PAE	2 GHz 12 GHz 18 GHz 22 GHz $P_{IN} = +23\text{ dBm}$	%	—	16.5 20.0 17.0 12.0	—
Input Return Loss	$P_{IN} = -20\text{ dBm}$	dB	—	15	—
Output Return Loss	$P_{IN} = -20\text{ dBm}$	dB	—	15	—
IDD (with RF drive)	$P_{IN} = +23\text{ dBm}$	mA	—	600	—
IG1	—	mA	—	8	—

3. Set I_{DSQ} according to bias procedures in page 3.**Maximum Operating Ratings**

Parameter	Rating
Input Power	25 dBm
Junction Temperature ^{4,5}	+150°C
Operating Temperature	-40°C to +85°C

4. Operating at nominal conditions with junction temperature $\leq +150^\circ\text{C}$ will ensure MTTF $> 1 \times 10^6$ hours.
5. Junction Temperature (T_J) = $T_C + \Theta_{JC} \cdot ((V \cdot I) - (P_{OUT} - P_{IN}))$
 Typical thermal resistance (Θ_{JC}) = 7°C/W .
- a) For $T_C = +85^\circ\text{C}$,
 $T_J = +145^\circ\text{C}$ @ 15 V, $I = 0.69\text{ A}$, $P_{OUT} = 33\text{ dBm}$, $P_{IN} = 23\text{ dBm}$

Absolute Maximum Ratings^{6,7}

Parameter	Absolute Maximum
Input Power	28 dBm
Drain Voltage	+16 V
Gate Voltage	-5 to 0 V
Junction Temperature ⁸	+175°C
Storage Temperature	-65°C to +125°C

6. Exceeding any one or combination of these limits may cause permanent damage to this device.
7. MACOM does not recommend sustained operation near these survivability limits.
8. Junction temperature directly effects device MTTF. Junction temperature should be kept as low as possible to maximize lifetime.

PRELIMINARY: Data Sheets contain information regarding a product MACOM has under development. Performance is based on engineering tests. Specifications are typical. Mechanical outline has been fixed. Engineering samples and/or test data may be available. Commitment to produce in volume is not guaranteed.

MACOM Technology Solutions Inc. (MACOM) and its affiliates reserve the right to make changes to the product(s) or information contained herein without notice.

For further information and support please visit: <https://www.macom.com/support>

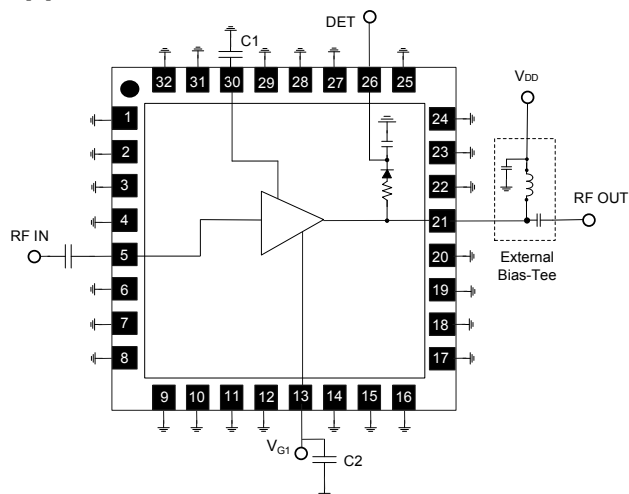
MAAP-011247



Power Amplifier, 2 W DC - 22 GHz

Preliminary - Rev. V1P

Application Schematic



Operating the MAAP-011247

Turn-on

1. Apply V_{G1} (-4.5 V).
2. Increase V_{DD} to 15 V.
3. Set I_{DSQ} by adjusting V_{G1} more positive (typically -3.4 V for $I_{DSQ} = 500$ mA).
4. Apply RF_{IN} signal.

Turn-off

1. Remove RF_{IN} signal.
2. Decrease V_{G1} to -4.5 V.
3. Decrease V_{DD} to 0 V.

Bill of Materials^{9,10,11}

Part	Value	Size	Comment
C1, C2	1 μ F	0402	bypass
U1	—	—	MAAP-011247

9. C1 & C2 are required for operation below 1 GHz.
 10. High power external bias tee was used for measurements.
 11. External DC block was used on input.

Handling Procedures

Please observe the following precautions to avoid damage:

Static Sensitivity

These electronic devices are sensitive to electrostatic discharge (ESD) and can be damaged by static electricity. Proper ESD control techniques should be used when handling these HBM Class 1A devices.

Biasing Conditions

Recommended biasing conditions are $V_{DD} = 15$ V, $I_{DSQ} = 500$ mA (controlled with V_{G1}).

V_{DD} Bias must be applied through a resonant free high inductance on the RF output line.

By-pass capacitor C1 for the auxiliary pad is for low frequency operation extension (below 1 GHz).

Recommended PCB Information

RF input and output are 50 Ω transmission lines.
 Single layer 8 mil Rogers RO4008 with 1/2 oz. Cu.
 Use copper filled vias under ground paddle.

Grounding

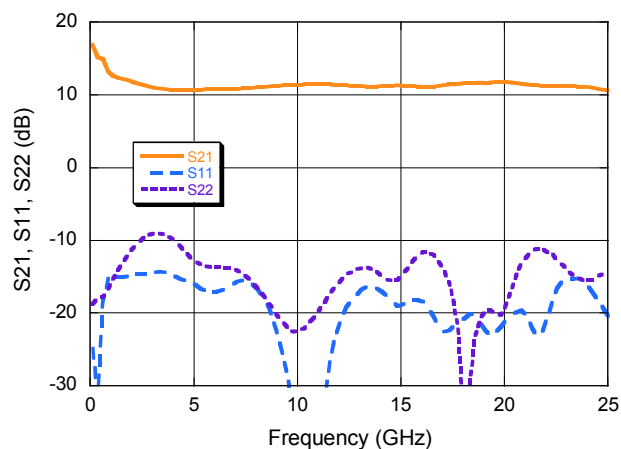
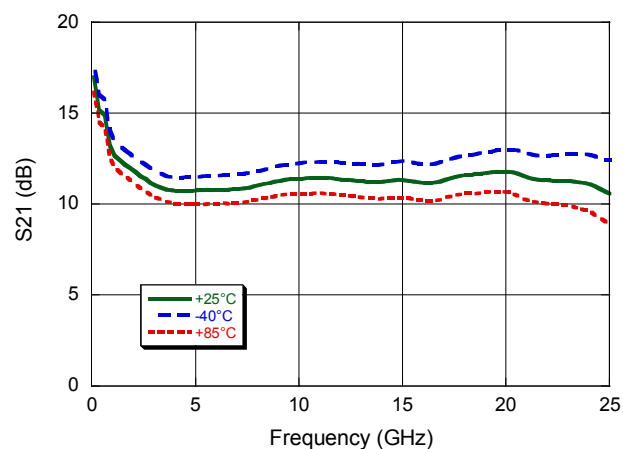
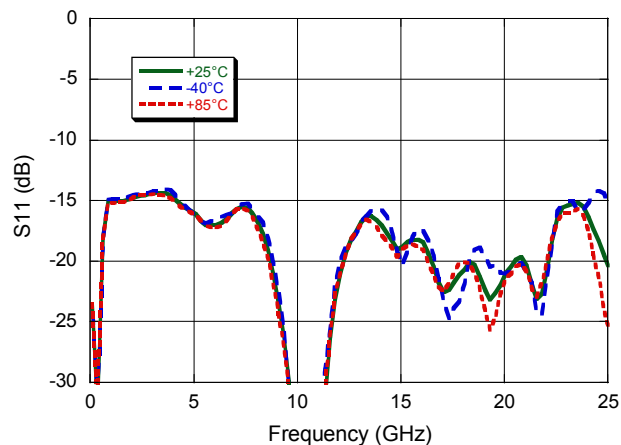
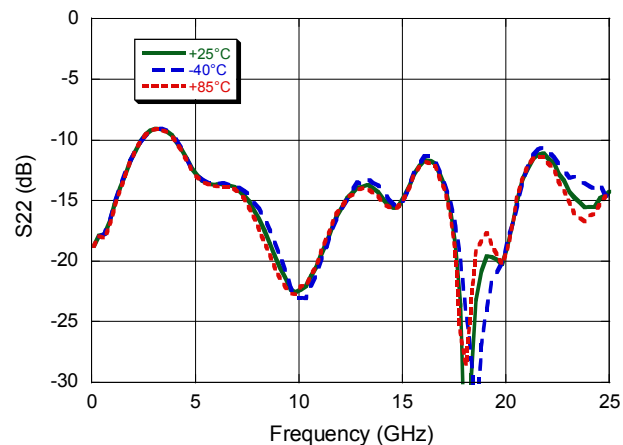
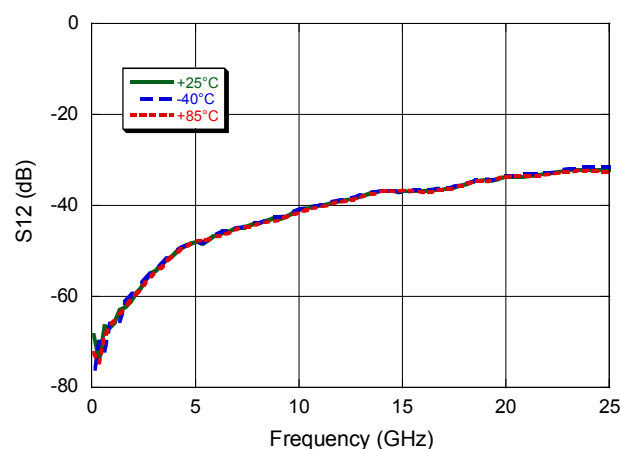
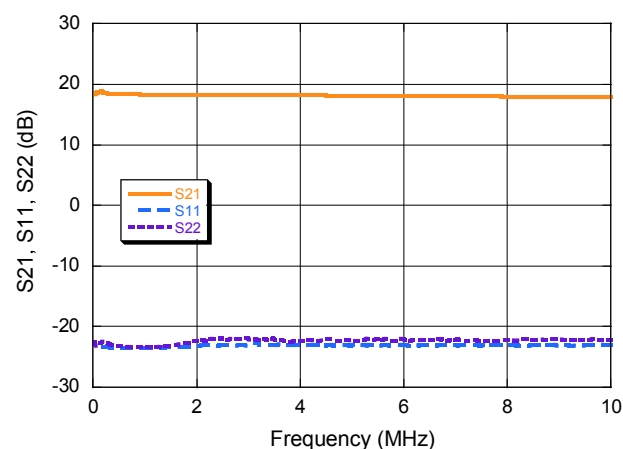
It is recommended that the total ground (common mode) inductance not exceed 0.03 nH (30 pH). This is equivalent to placing at least four 8-mil (200- μ m) diameter vias under the device, assuming an 8-mil (200- μ m) thick RF layer to ground.

Preliminary Information

MAAP-011247



Power Amplifier, 2 W DC - 22 GHz

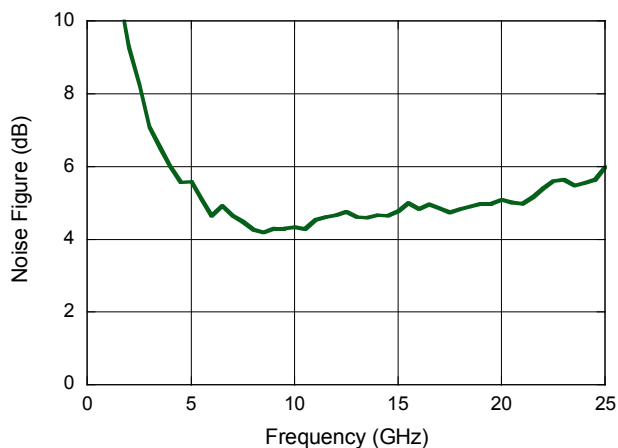
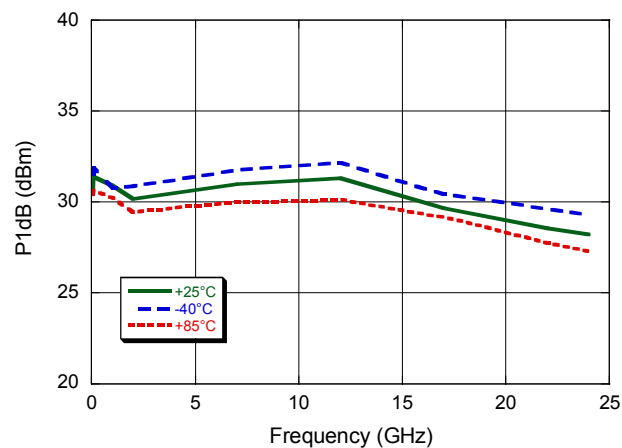
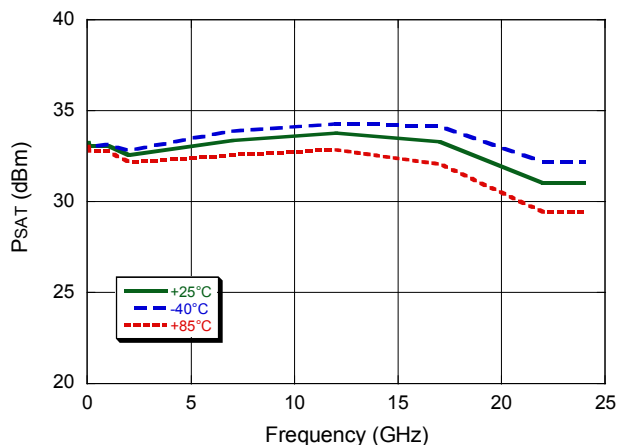
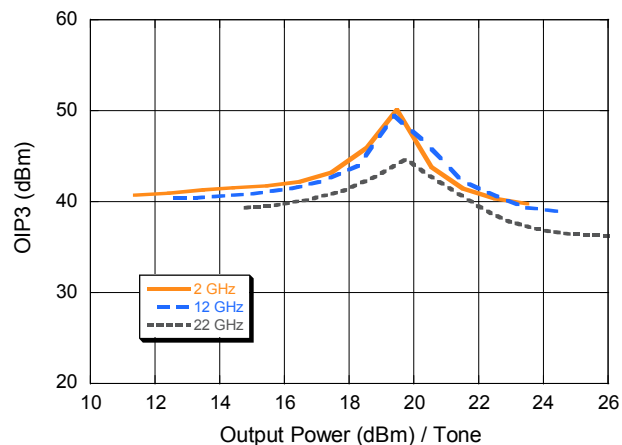
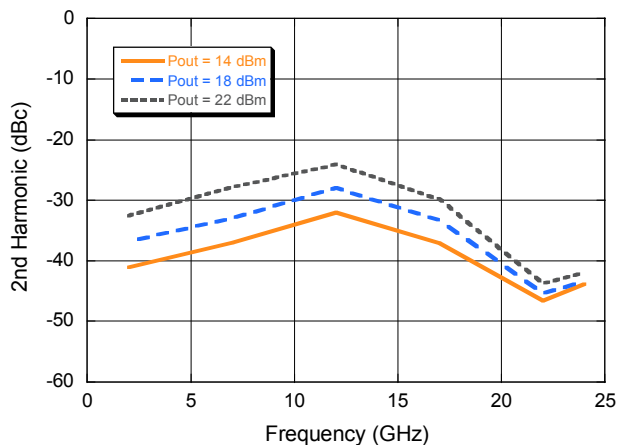
*Preliminary - Rev. V1P***Typical Performance Curves: $V_{DD} = 15\text{ V}$, $I_{DSQ} = 500\text{ mA}$, $V_{G1} = -3.4\text{ V}$ typical****S Parameters****Gain****Input Return Loss****Output Return Loss****Isolation****S Parameters @ Low Frequency**

Preliminary Information

PRELIMINARY: Data Sheets contain information regarding a product MACOM has under development. Performance is based on engineering tests. Specifications are typical. Mechanical outline has been fixed. Engineering samples and/or test data may be available. Commitment to produce in volume is not guaranteed.

MACOM Technology Solutions Inc. (MACOM) and its affiliates reserve the right to make changes to the product(s) or information contained herein without notice.

For further information and support please visit: <https://www.macom.com/support>

MAAP-011247
**Power Amplifier, 2 W
DC - 22 GHz**
Preliminary - Rev. V1P
Typical Performance Curves: $V_{DD} = 15\text{ V}$, $I_{DSQ} = 500\text{ mA}$, $V_{G1} = -3.4\text{ V}$ typical
Noise Figure **P_{1dB} over Temperature** **P_{SAT} over Temperature****Output IP3 vs. P_{OUT} / Tone****2nd Harmonic**

Preliminary Information

PRELIMINARY: Data Sheets contain information regarding a product MACOM has under development. Performance is based on engineering tests. Specifications are typical. Mechanical outline has been fixed. Engineering samples and/or test data may be available. Commitment to produce in volume is not guaranteed.

MACOM Technology Solutions Inc. (MACOM) and its affiliates reserve the right to make changes to the product(s) or information contained herein without notice.

For further information and support please visit: <https://www.macom.com/support>

MAAP-011247

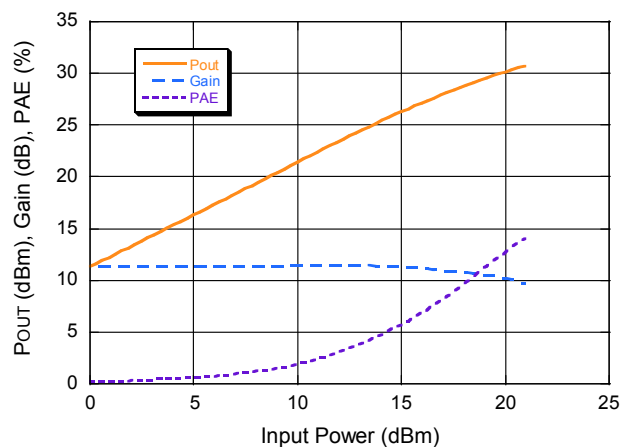


Power Amplifier, 2 W DC - 22 GHz

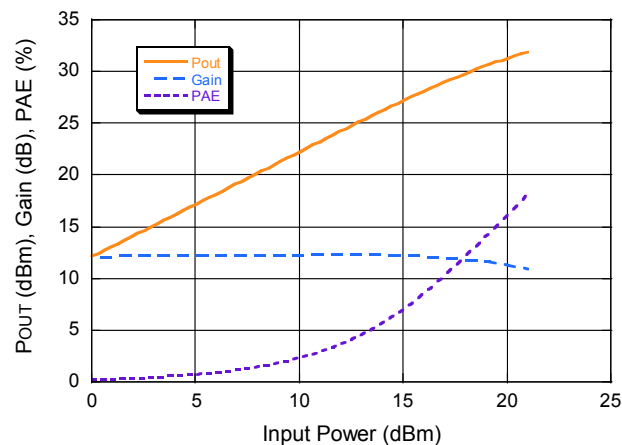
Preliminary - Rev. V1P

Typical Performance Curves: $V_{DD} = 15\text{ V}$, $I_{DSQ} = 500\text{ mA}$, $V_{G1} = -3.4\text{ V}$ typical

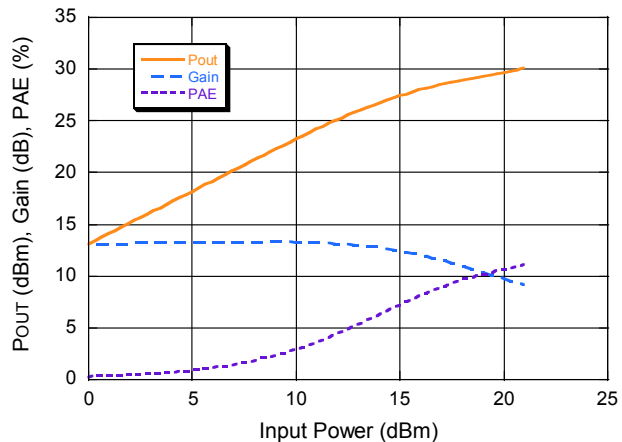
Power Compression @ 2 GHz



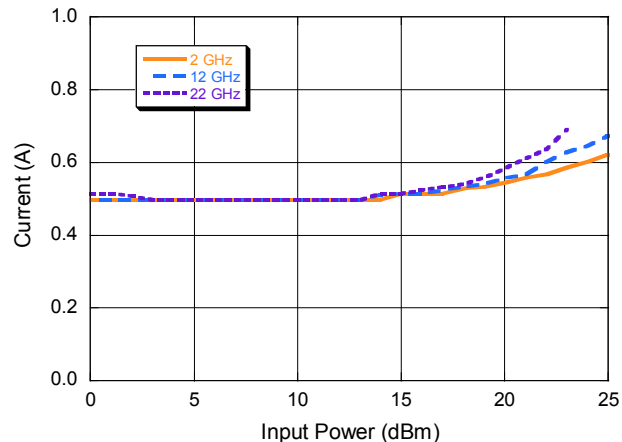
Power Compression @ 12 GHz



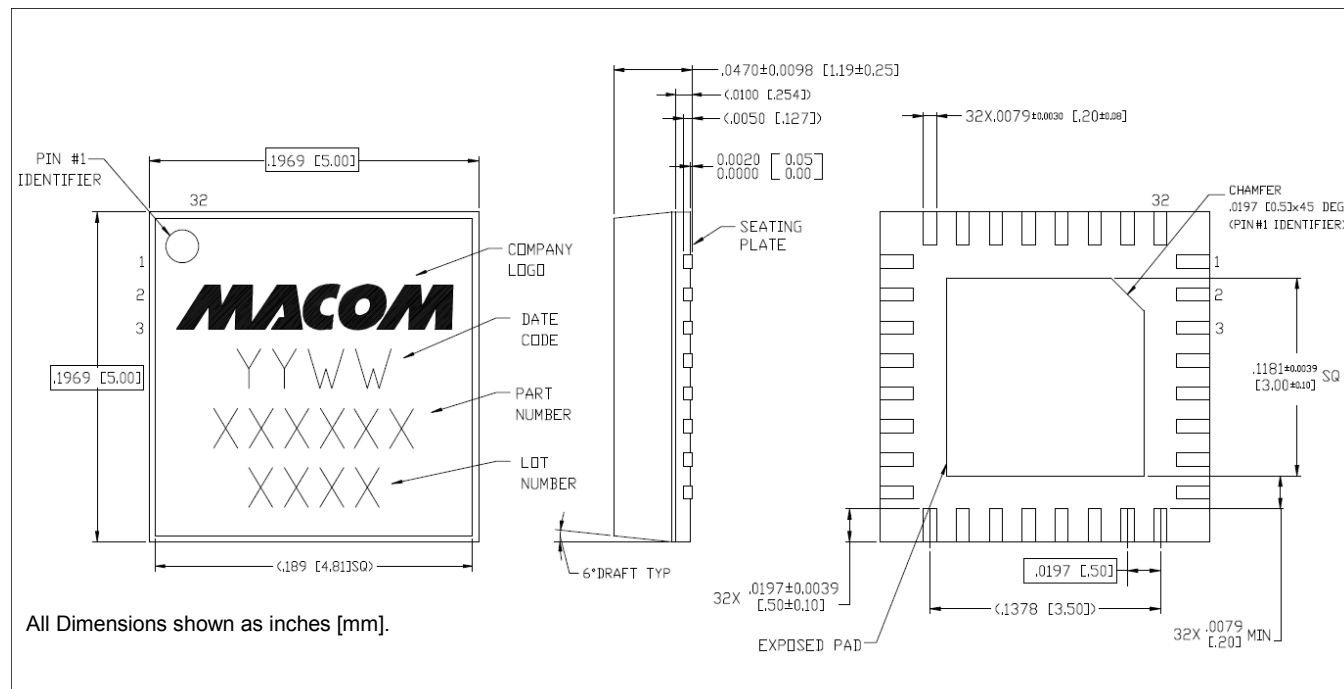
Power Compression @ 22 GHz



Current



Preliminary Information

MAAP-011247**MACOM™****Power Amplifier, 2 W
DC - 22 GHz****Preliminary - Rev. V1P****Lead-Free 5 mm 32-lead AQFN Package†**

† Reference Application Note S2083 for lead-free solder reflow recommendations.
 Meets JEDEC moisture sensitivity level 3 requirements.
 Plating is NiPdAu.

Preliminary Information

MAAP-011247**Power Amplifier, 2 W
DC - 22 GHz****Preliminary - Rev. V1P**

Preliminary Information

MACOM Technology Solutions Inc. All rights reserved.

Information in this document is provided in connection with MACOM Technology Solutions Inc ("MACOM") products. These materials are provided by MACOM as a service to its customers and may be used for informational purposes only. Except as provided in MACOM's Terms and Conditions of Sale for such products or in any separate agreement related to this document, MACOM assumes no liability whatsoever. MACOM assumes no responsibility for errors or omissions in these materials. MACOM may make changes to specifications and product descriptions at any time, without notice. MACOM makes no commitment to update the information and shall have no responsibility whatsoever for conflicts or incompatibilities arising from future changes to its specifications and product descriptions. No license, express or implied, by estoppel or otherwise, to any intellectual property rights is granted by this document.

THESE MATERIALS ARE PROVIDED "AS IS" WITHOUT WARRANTY OF ANY KIND, EITHER EXPRESS OR IMPLIED, RELATING TO SALE AND/OR USE OF MACOM PRODUCTS INCLUDING LIABILITY OR WARRANTIES RELATING TO FITNESS FOR A PARTICULAR PURPOSE, CONSEQUENTIAL OR INCIDENTAL DAMAGES, MERCHANTABILITY, OR INFRINGEMENT OF ANY PATENT, COPYRIGHT OR OTHER INTELLECTUAL PROPERTY RIGHT. MACOM FURTHER DOES NOT WARRANT THE ACCURACY OR COMPLETENESS OF THE INFORMATION, TEXT, GRAPHICS OR OTHER ITEMS CONTAINED WITHIN THESE MATERIALS. MACOM SHALL NOT BE LIABLE FOR ANY SPECIAL, INDIRECT, INCIDENTAL, OR CONSEQUENTIAL DAMAGES, INCLUDING WITHOUT LIMITATION, LOST REVENUES OR LOST PROFITS, WHICH MAY RESULT FROM THE USE OF THESE MATERIALS.

MACOM products are not intended for use in medical, lifesaving or life sustaining applications. MACOM customers using or selling MACOM products for use in such applications do so at their own risk and agree to fully indemnify MACOM for any damages resulting from such improper use or sale.